



*Aviation Safety Program*

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# ***NASA***

# ***Aviation Safety Program***

## ***Overview & Technology Strategies***

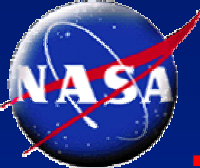
**Integrated CNS Workshop**

**Cleveland, OH**

**May 1-3, 2001**

**Douglas A. Rohn**

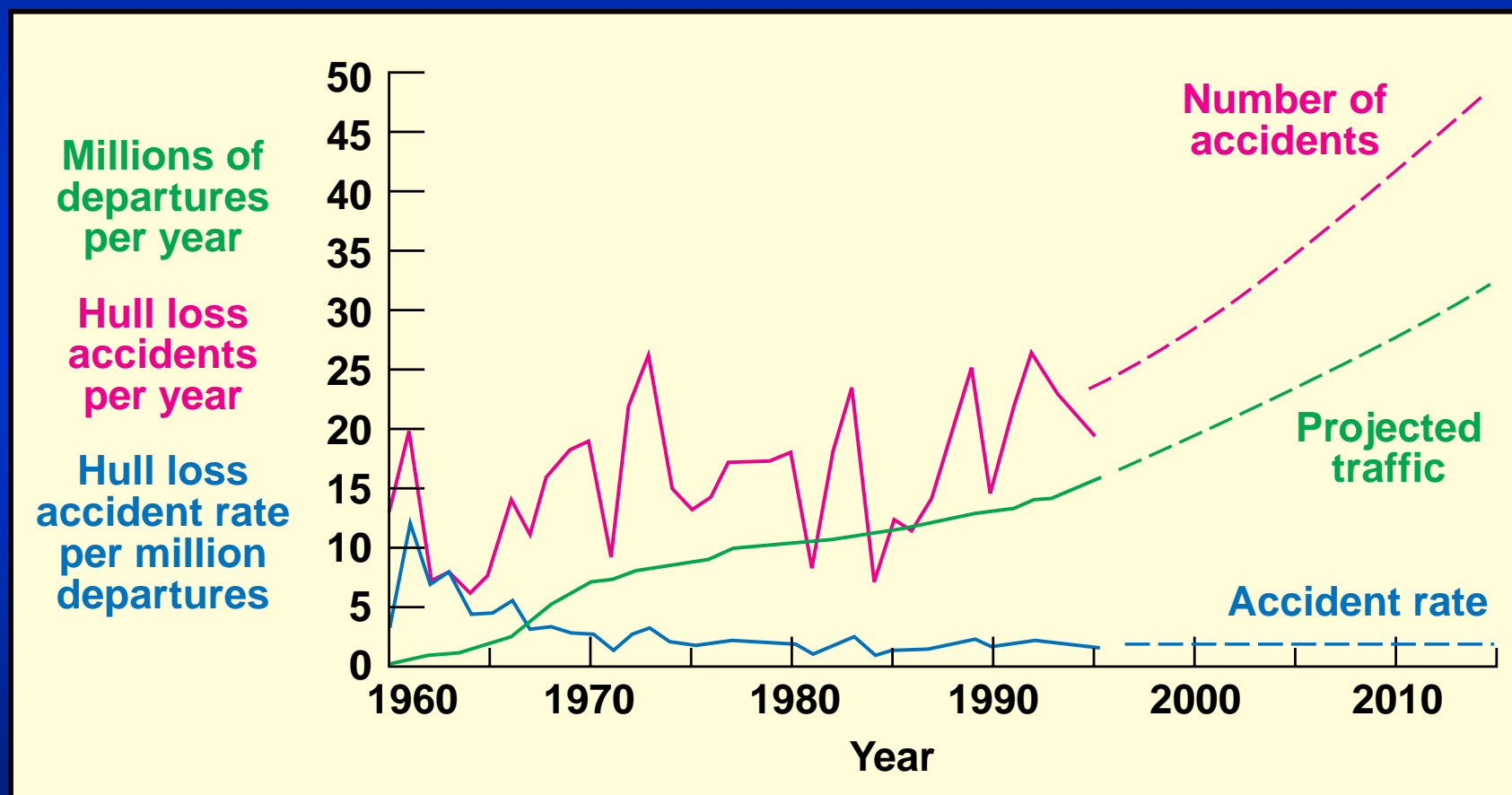
**Aviation Safety Program**



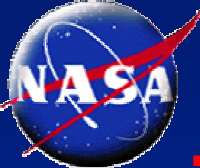
# National Challenge

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**If Current Accident Rate Does Not Decline  
And Traffic Increases as Forecast . . .**



(Boeing Data)



# 1 Week in December = 31 GA Accidents

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## (14 Fatal, 32 Fatalities)

### Monday Dec-06-99

BETHEL, AK	Cessna 208B	Nonfatal
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### Tuesday Dec-07-99

BETHEL, AK	Cessna 207	Fatal (6)
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### Wednesday Dec-08-99

AVA, MO	Cessna 172M	Nonfatal
ELIDA, NM	Cessna T210L	Fatal (1)
PELHAM, AL	Piper PA-32RT-300T	Fatal (1)
ST. ELMO, AL	American AA5	Nonfatal
WOOSTER, OH	Cessna 172L	Nonfatal

### Thursday Dec-09-99

DANVILLE, IL	Cessna 310N	Fatal (2)
BRANSON, MO	Cessna 525	Fatal (6)
PIKEVILLE, NC	Cessna 172M	Nonfatal
MAIZAL	Beech B95A	Fatal (1)
HASBROUCK HTS., NJ	Beech 58TC	Fatal (4)

### Friday Dec-10-99

GILLETTE, WY	Cessna 421C	Nonfatal
SCOTTSDALE, AZ	Piper PA-31-350	Nonfatal
HARPER, OR	Cessna 140A	Fatal (1)

### Saturday Dec-11-99

WASILLA, AK	Bellanca 8GCBC	Nonfatal
CALI	Bell UH-1H	Fatal (1)
BROOKSVILLE, MS	Cessna U-3A	Fatal (1)
PLANT CITY, FL	Piper PA-28-161	Nonfatal
PLANT CITY, FL	Cessna 152	Nonfatal
READING, PA	Mooney M20-C	Nonfatal

### Sunday Dec-12-99

ST. CHARLES, MO	Cessna 210D	Fatal (2)
MANKATO, MN	Piper PA-28-180	Nonfatal
JAMESTOWN, ND	WITTMAN W-8	Fatal (2)
SPRINGHILL, LA	Cessna 172N	Nonfatal
STERLING CITY, TX	LANCAIR 235/320	Nonfatal
FRANKLIN, NY	RAF 2000 GTX SE	Nonfatal
GOULDSBORO, PA	Isreal Aircraft Ind 112	Fatal (3)
WALES, ME	Piper PA-22-108	Nonfatal
SHAMOKIN, PA	Christen PITTS S-2B	Nonfatal
MISSOULA, MT	Mooney M20-M	Fatal (1)



**“Develop and demonstrate technologies that contribute to a reduction in the aviation fatal accident rate by a factor of 5 by year 2007 and by a factor of 10 by year 2022”**

**Langley Research Center (Lead)**

**Ames Research Center**

**Glenn Research Center**

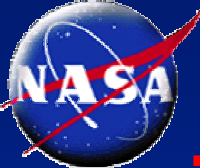
**Dryden Flight Research Center**



**• 2000 - 2004**

**• \$383M**

**Close coordination with  
FAA & Industry**



# AvSP Organization

## Aviation Safety Program

### Aviation Safety Program Office

Michael Lewis, Director

George Finelli, Deputy Director

Connie Smith, Secretary

Brian Smith, Dep Prog Mgr (ARC)

Frank Jones, Asst Tech Mgmt

Jaiwon Shin, Dep Prog Mgr (GRC)

Glenn Bond, Senior Prog Analyst

#### 1.1 Technical Integration

Vincent Schultz (LaRC)

#### 1.2 Program Integration

Michael Basehore (FAA)

Carrie Walker (Hq)

## Program

## Projects

#### 2.1 Aviation System Monitoring & Modeling

Brian Smith  
Acting (ARC)

#### 2.2 System-Wide Accident Prevention

Tina Beard  
(ARC)

#### 2.3 Single Aircraft Accident Prevention

John White  
(LaRC)

#### 2.4 Weather Accident Prevention

Shari-Beth Nadell  
Acting, (GRC)

#### 2.5 Accident Mitigation

Douglas Rohn  
(GRC)

#### 2.6 Synthetic Vision

Daniel Balze  
(LaRC)

## Elements

- System Monitoring
- Data Sharing
- Data Analysis

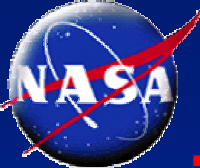
- Human Error Modeling
- Maintenance Human Factors
- Training

- Vehicle Health Management & Flt Crit Sys Design
- Propulsion Sys Health Management
- Control Upset Prevention & Recovery

- Wx Info Distribution & Presentation
- Weather Information Communication
- Turbulence Detection & Mitigation

- Systems Approach to Crashworthiness
- Fire Prevention

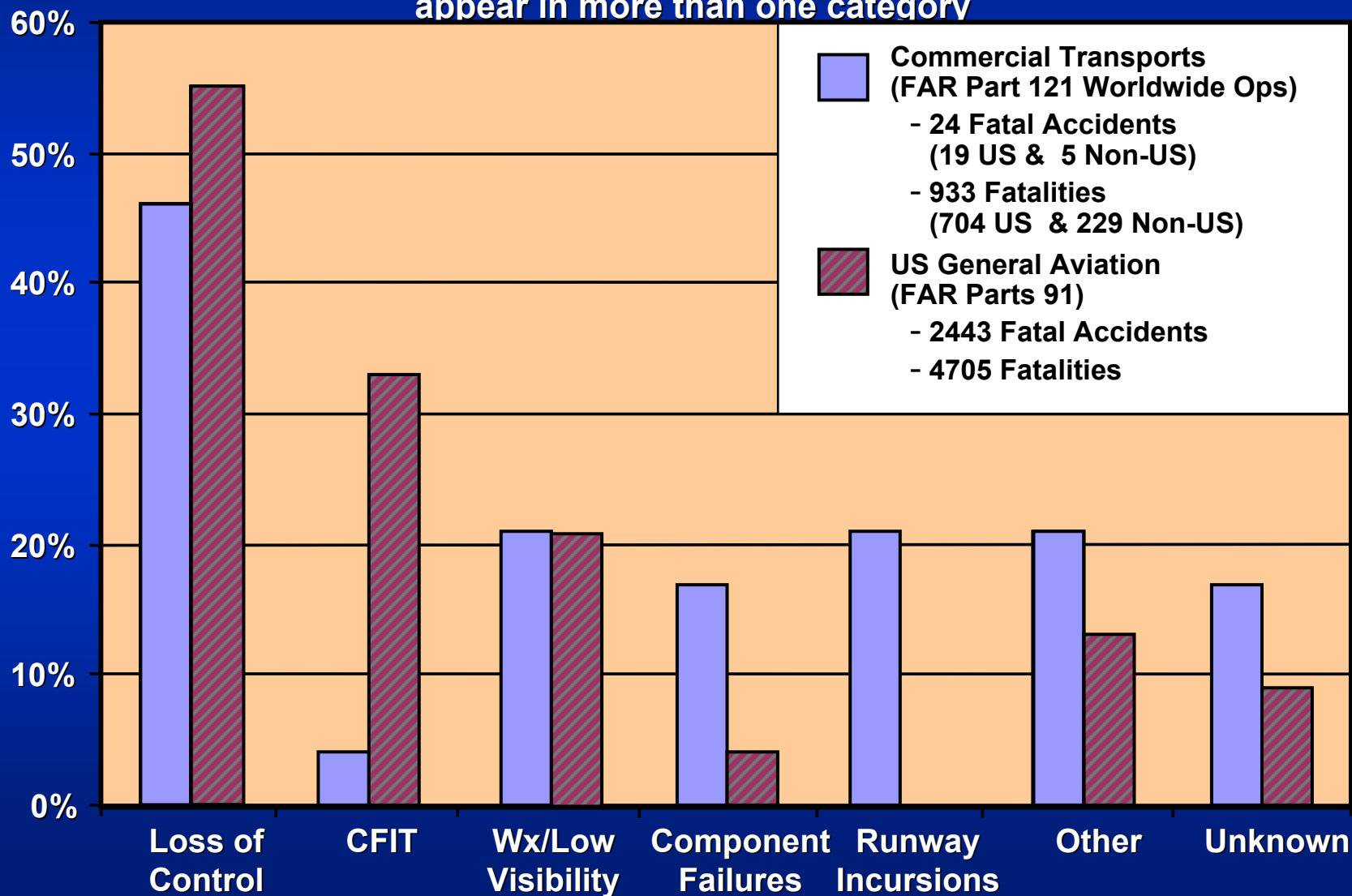
- Commercial & Business Aircraft
- GA & Rotorcraft
- Enhanced Vision Sensors and Enabling Technologies

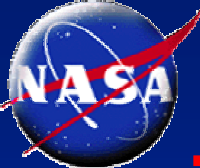


# Fatal Accident Distribution

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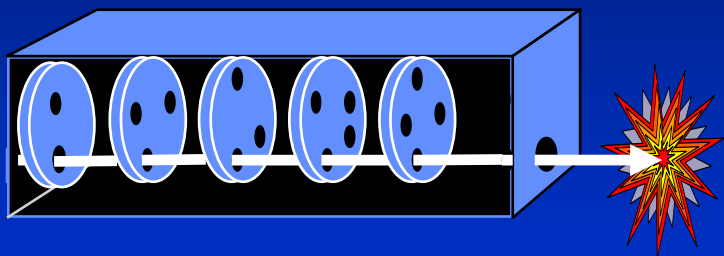
NTSB 1990-1996, Accidents with multiple causes/factors  
appear in more than one category



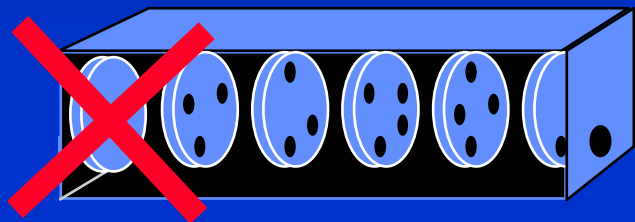


# Accident Prevention Strategies

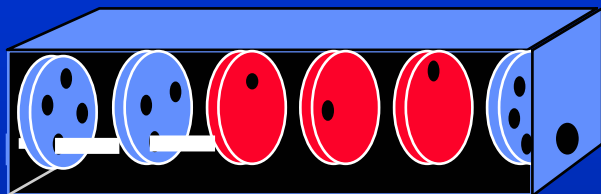
*Aviation Safety Program*



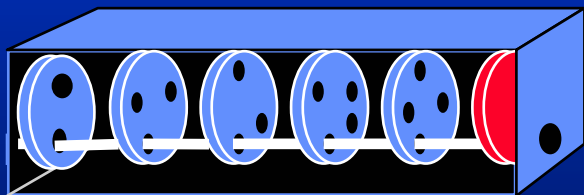
*Challenge: Develop solutions to eliminate entire categories of accidents, not single cases*



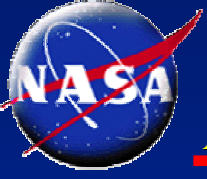
**Strategy A:**  
**"Prevent Initiation"**



**Strategy B:**  
**"Break the Chain"**



**Strategy C:**  
**"Block the Failures"**



# The "AvSP Eight"

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## Technology Strategies for Aviation Safety

- 1) Make every flight the equivalent of clear-day operations



## Aviation Safety Program

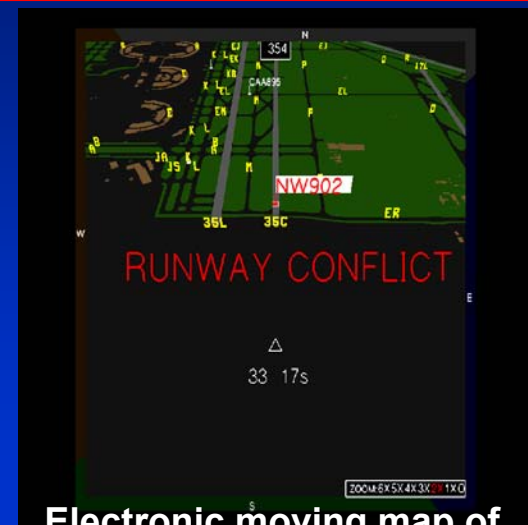
# Synthetic Vision



Synthetic Vision primary flight display concept at DFW



Research aircraft flight deck



Electronic moving map of airport depicted on aircraft's navigation display



Asheville, NC

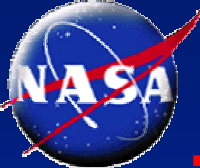


Synbology depicted on head-up display



SRTM World-Wide Digital Map

Synthetic Vision System technologies utilize terrain database, precise GPS navigation, and integrity-monitoring sensors to provide an unrestricted synthetic external view



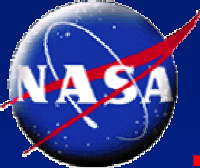
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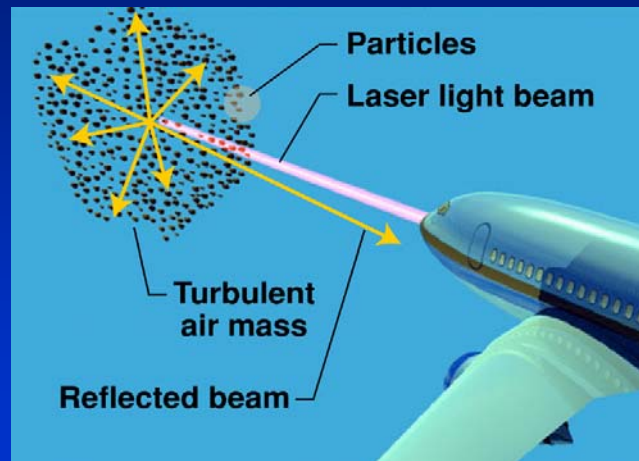
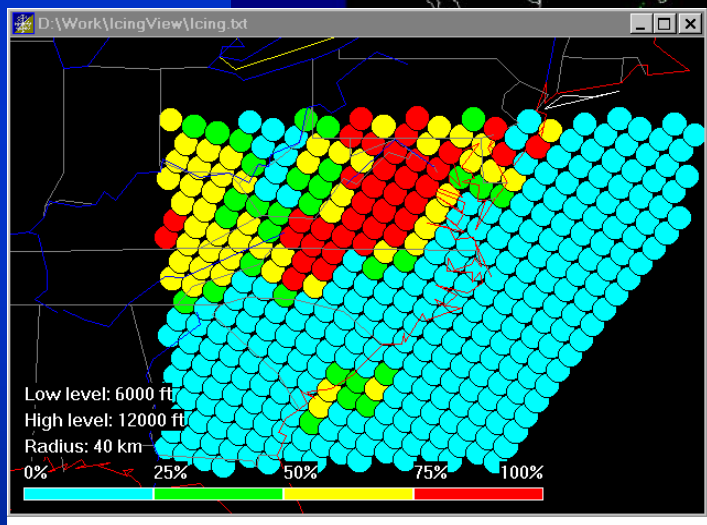
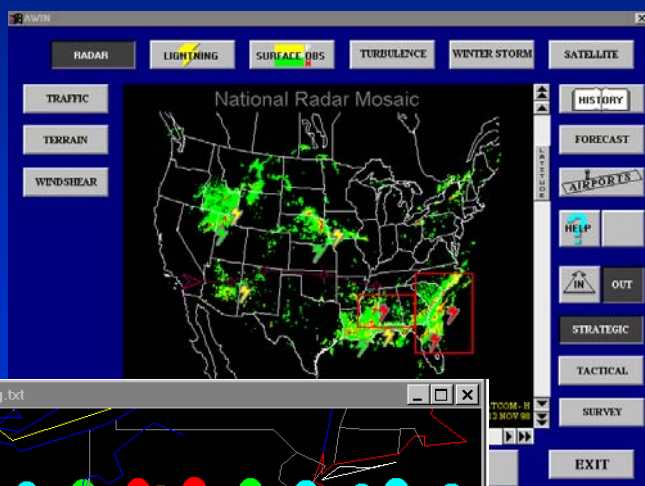
## Technology Strategies for Aviation Safety

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- 2) Eliminate severe turbulence as an aviation hazard
- 3) Bring intelligent weather decision making - based on worldwide, real-time hazard awareness - to every cockpit

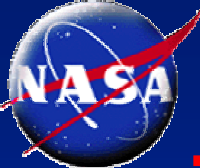


# Weather Accident Prevention

## Aviation Safety Program



*Pilots need to know:  
what kind of weather they are flying into, how to avoid  
weather problems, and what to do when facing adverse conditions*



# AWIN Technologies for GA and Commercial Aircraft

## Aviation Safety Program



Weather Information Network  
(Honeywell-WINN) Avionitec  
Display in NASA B-757



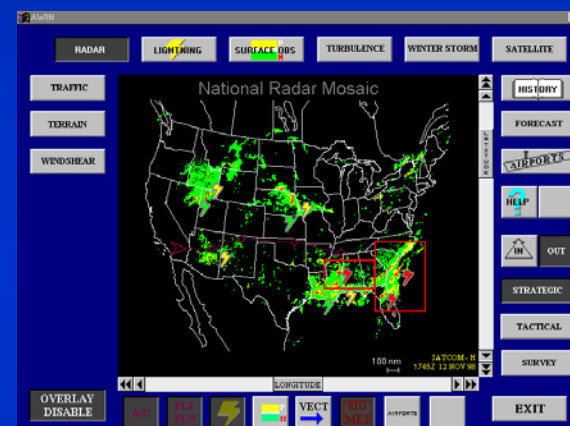
Multi-function Display Installation in  
General Aviation Cockpit



Tethered general aviation weather  
information system on NASA  
LaRC BE200 King Air



The Worldspace Afristar Satellite with  
close-up of the Rockwell-Collins receive patch  
antenna



Implementation of Boeing AWIN  
cockpit weather display in FedEx MD-  
11, USAF C-135C, and NC-21

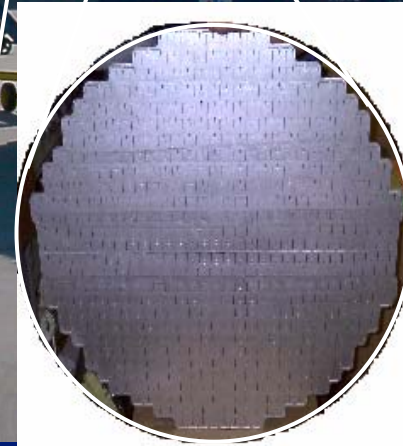


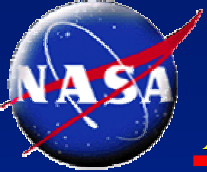
# Turbulence Radar

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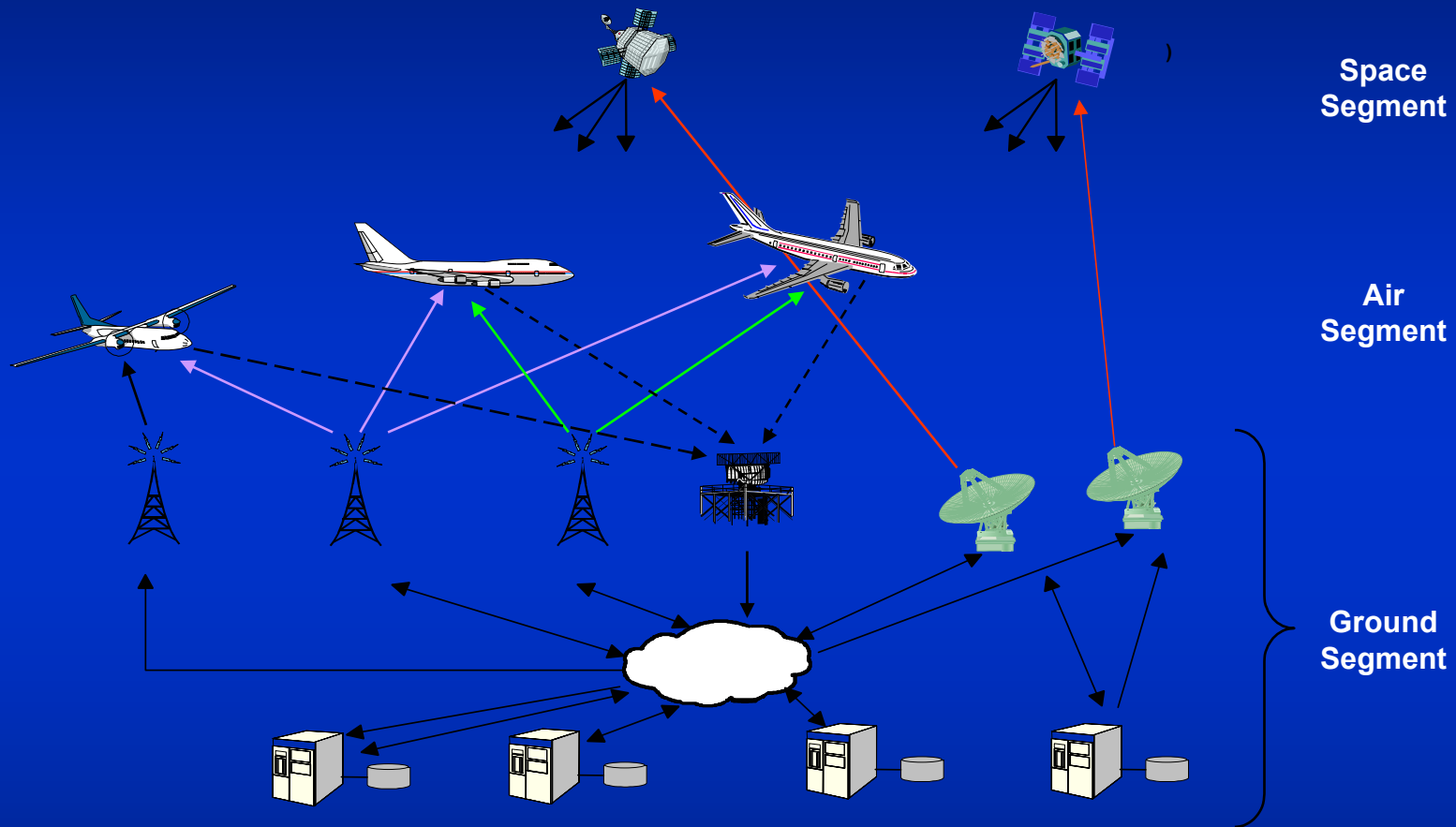
~1 GB of Recorded Data  
(Approach and Interaction with Turbulent Cells)





# WINCOMM

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**Weather Information Communications Architecture**



# The "AvSP Eight"

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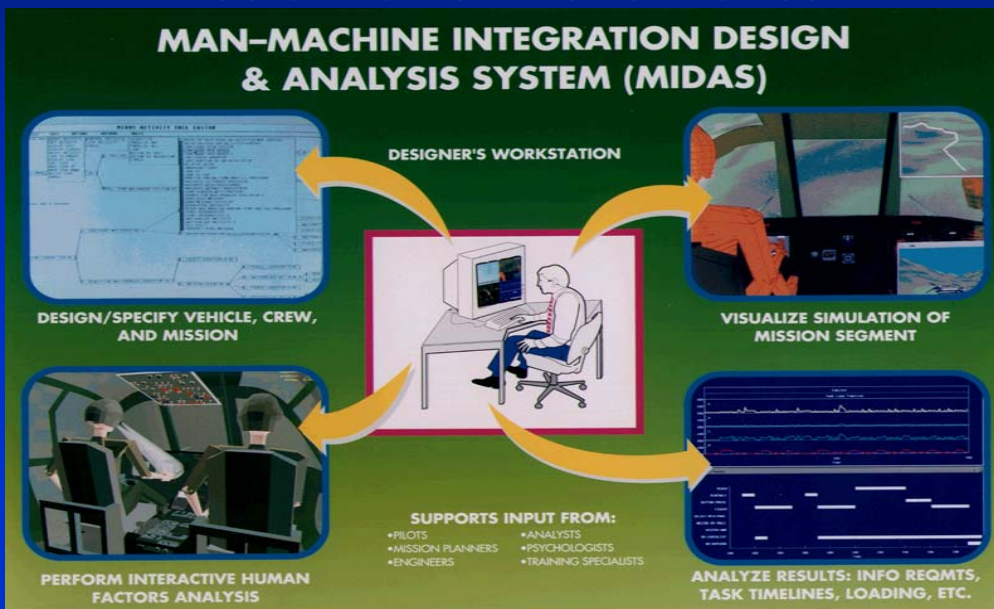


# System-Wide Accident Prevention

## Aviation Safety Program

### Predict Human Performance

#### MAN-MACHINE INTEGRATION DESIGN & ANALYSIS SYSTEM (MIDAS)



### Situational Awareness and Maintenance Procedures

**Visual Cues**

Observe the windshield and other areas for visual cues. Look at windshield wiper blades, prop spinner, antenna, wing leading edges and engine inlets.

**Engine Inlets**

Cues for Detecting Ice - Visual Cues

Module II - How to Detect Ice

**In-Flight Icing**

Navigation CD-ROM icon

Difficult aviation weather hazard to forecast.

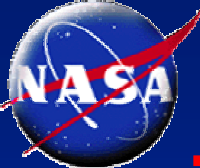
Determine which areas contain water droplets and ice will be during observation of icing is not possible.

**Marcia Politovich**  
Research Meteorologist - NCAR

Module III - Strategies to Avoid Ice

**In-Flight Icing**

### Training



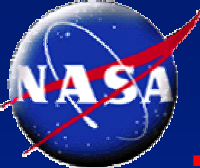
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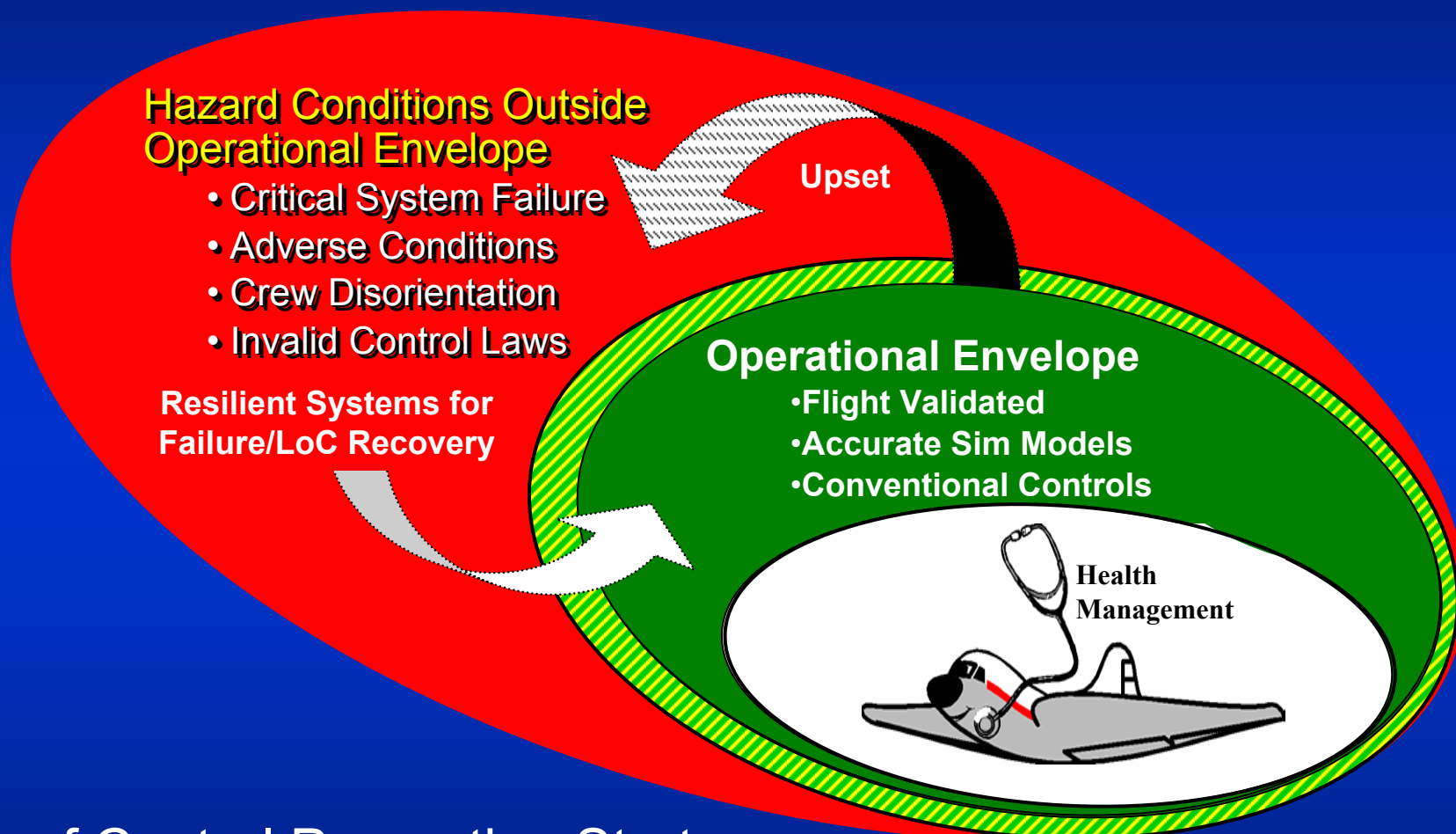
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- 5) Continuously track, diagnose, and restore the health of on-board systems, enabling self-healing designs and “refuse-to-crash aircraft”



# Single Aircraft Accident Prevention

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## Loss of Control Prevention Strategy

- **Health Management** to prevent component or system failure
- Resilient Systems to recover if a failure or loss of control occurs



# The “AvSP Eight”

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- 6) Monitor and assess all data from every flight for both known and unknown issues



# Aviation System Monitoring & Modeling

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## The People



600,000 Pilots  
500,000+ Cabin Crew  
17,500 Air Traffic  
Controllers  
380,000 Maintenance  
Personnel

**Aviation Safety  
Reporting System**

**National Aviation  
Operations  
Monitoring Service**

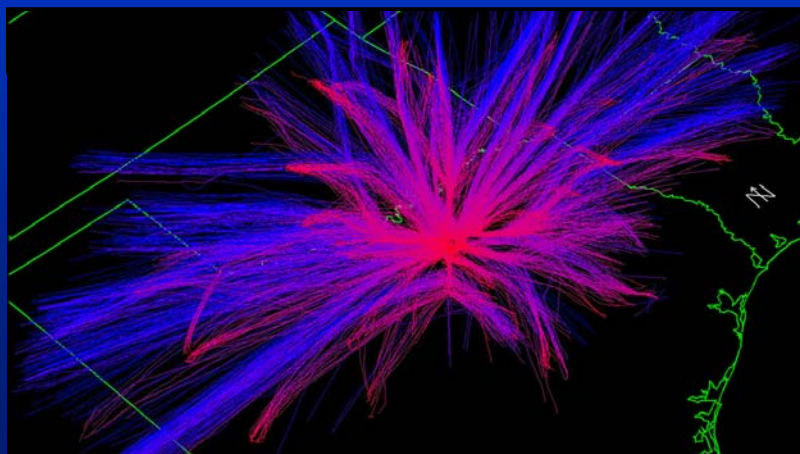
## The Aircraft



A320  
200+ parameters/sec  
X14 hrs/day  
= 10,000,000 data  
points/day

**Aviation  
Performance  
Measurement  
System**

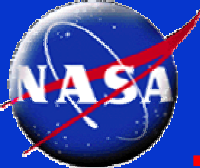
## The System



DFW  
>2500 ops/day

Nationwide  
>40 million ops/yr

**Performance  
Data Analysis  
and Reporting  
System**



# Tools for Operational Performance Monitoring

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**Example:**

**Targeted  
Queries**

Search any  
portion of the  
database  
prescribed by  
the user

for any pattern  
of flight  
parameters  
defined by  
the user.

APMS - jchan, Maintenance, Limited access

File Edit Options Help

View Routine Events View Exceedances Special Events SVD (typicality)

Define Special Events - "Unstabilized Approach" Created by: B. Lynch on April 16, 1998

Conditions:

A Flaps Speed Exceedance

and

B High ROD < 10000 ft

Parameter/Rate	Relation	Value	Minimum Duration	Maximum Duration
Vertical Speed Max (10Hz)	less than	-2000	any	none
HAT (2Hz)	greater than	10,000	any	none
Turbulence Index (5Hz)	equal to	high	5 sec	none

Interval: Between 10,000 ft above landing and Touchdown

or

C Late Power Change

or

D create new entry...

Schematic view:

A Flaps Speed Exceedance

B High ROD < 10000ft

C Late Power Change

Search String: A + [B or C]

Search Filters:

Phase: Approach Aircraft: ALL Flights To: ALL Flights From: SFO Runway: 28R From Date: 01/98 To Date: 04/98

Save Event Save Event As... Close Cancel

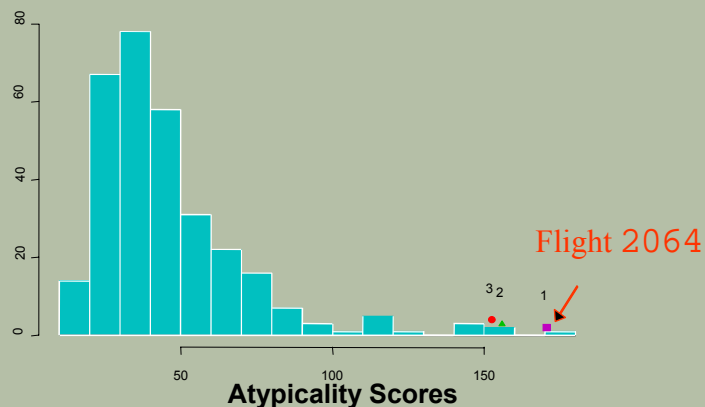


# Repeatability Can Be Mathematically Measured!

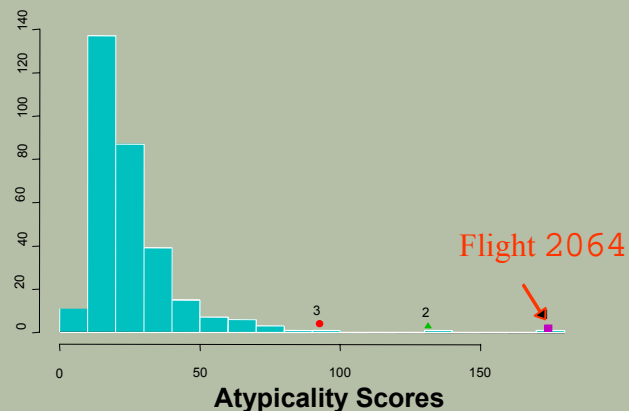
## Aviation Safety Program

APMS Example:  
300+  
Approaches  
evaluated for  
atypicalities

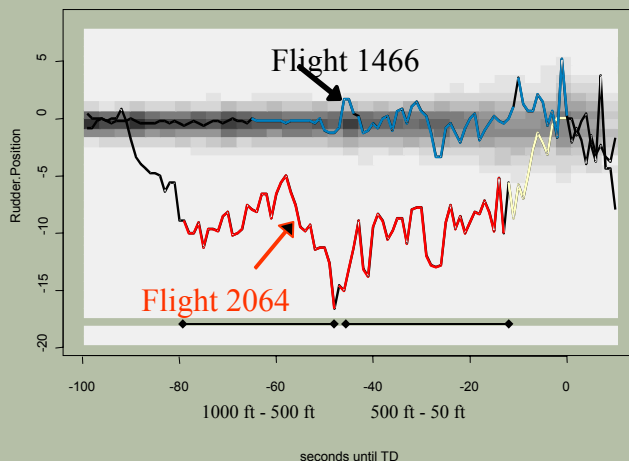
Overall Atypicality Score for Approaches  
1000 ft - 500 ft



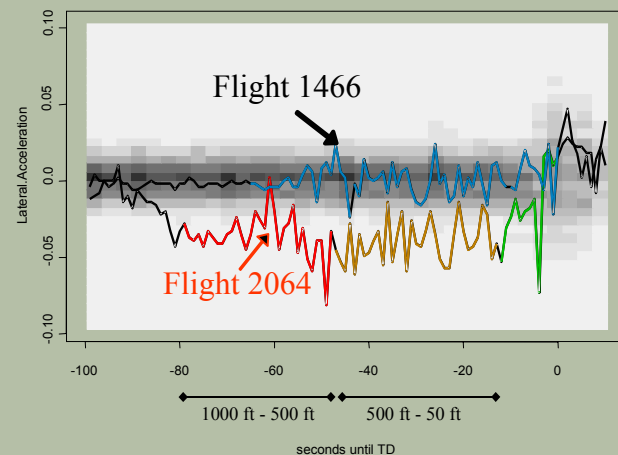
Atypicality Score for Flight Controls  
Parameter Set (1000 ft - 500 ft)



Rudder Position for  
Flights 2064 & 1466



Lateral Acceleration for  
Flights 2064 & 1466





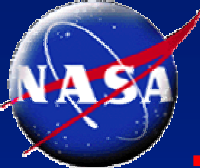
# The “AvSP Eight”

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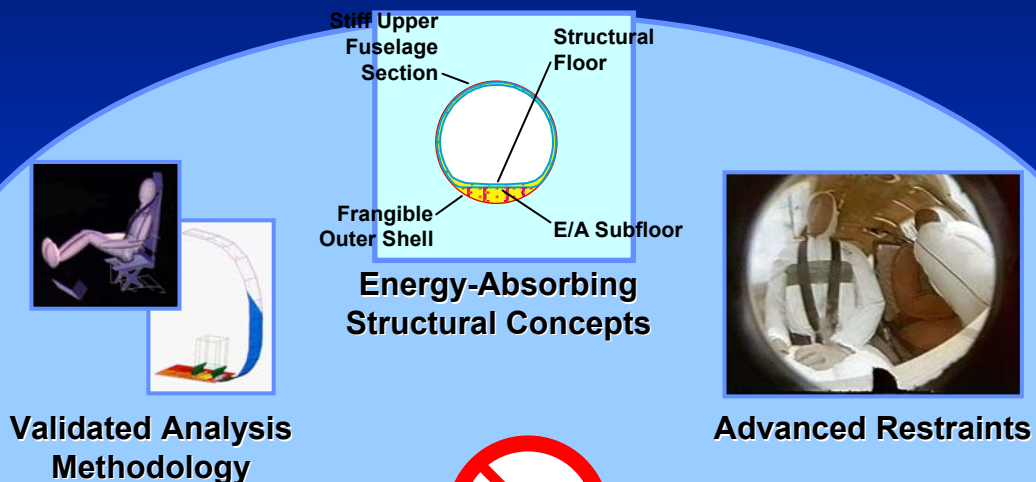
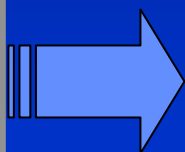
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- 4) Improve human/machine integration in design, operations, and maintenance
- 5) Continuously track, diagnose, and restore the health of on-board systems, enabling self-healing designs and “refuse-to-crash aircraft”
- 6) Monitor and assess all data from every flight for both known and unknown issues
- 7) Increase survivability when accidents do occur



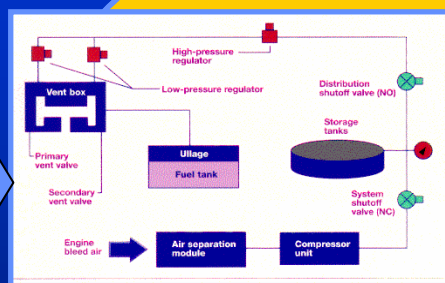
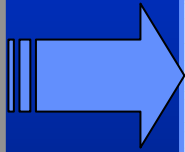
# Accident Mitigation

More-Crashworthy designs to increase human survivability



## Potential Solutions

Prevent in-flight fires and post-crash fire hazard



**Inerting & Oxygen**

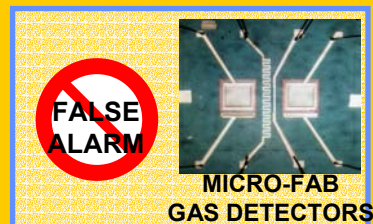
**FUEL SPILL**

**Crash-Resistant Fuel Systems**

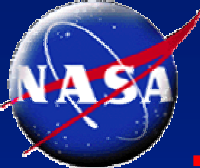
**Suppression**

**Fire-Safe Fuels**

**Low Heat-Release Materials**



**Detection**



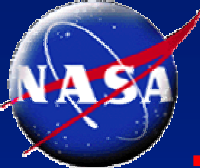
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- 7) Increase survivability when accidents do occur
- 8) Anticipate and prepare for future issues as the aviation system evolves



# Next steps....

## *Aviation Safety Program*

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### Integrated communications architecture

- Dissemination of all safety-related data
  - Weather, Air Traffic, Terrain, Obstacles, Flow Controls
  - Health Management
- Distributed NAS-wide database
  - Easy access to any user
  - Enables near real-time, collaborative decision making

### Integrated hazard avoidance

- Flight deck integration of all hazard information
  - Weather, Air Traffic, Terrain, Obstacles, Flow Controls
  - Health Management
- Human interaction & response to information



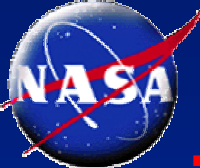
# Next steps....

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## Immersive flight deck

- Revolutionized flight deck design
- Automation technology
  - Info Management & Decision Aiding
- Advanced/Adapted NAS/ATM procedures



# AvSP Summary

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- National challenge
- Technology strategies
- CNS opportunities